UNITED STATES AIR FORCE MATERIALS TECHNOLOGY HIGHLIGHTS

*Air Force Research Laboratory*

Materials & Manufacturing Directorate

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# ML Converts Mine Area Clearance Vehicle

Air Force Research Laboratory's Materials and Manufacturing Directorate (AFRL/ML) researchers modified a Mine Area Clearance Vehicle (MACV) and converted it to a remotely operated vehicle.

Operating this vehicle remotely, keeps personnel safely out of areas that may contain mines and improvised explosive devices. By adding the global positioning system, the researchers have given the operators better control of the vehicle and enabled them to receive feedback that ensures accuracy in clearing the affected areas.

The Headquarters Air Combat Command Civil Engineer (HQ ACC/CE) expressed strong interest in being able to remotely employ a vehicle system and remove the man-in-the-seat during explosive ordnance clearance operations. The Hydrema 910 (Mine Clearance Vehicle) MCV-2 Flail System, hereafter referred to as the Mine Area Clearance Vehicle (MACV), was found to be a suitable vehicle for the task.

The MACV is a commercially available mine clearing system designed by Hydrema, a Danish commercial heavy equipment manufacturer. The vehicle is integrated into an articulated chassis so that all four wheels are in contact with the ground at all times. When being driven on roads the cab is to the front of the vehicle, however during mine clearing operations, the vehicle is driven in reverse with the cab to the rear. The vehicle is powered by two Perkins 1006-6TW six-cylinder turbocharged diesel engines. One is used for driving the vehicle and is coupled to a six-speed semi-automatic transmission. The second engine powers the mine clearing flails.

During mine clearing operations, a separate hydrostatic transmission is used which gives a continuously variable speed and considerable force. The complete flail system can be rapidly lowered into position at the rear of the vehicle and can clear a mine path 3.5 meters wide. During mine clearing, the vehicle can be manually operated from the cab using a joystick, or it can be remotely operated through the use of a computerized fully automatic pilot steering system. When being used in the latter configuration, the operator needs only to select a number of key parameters, for example depth, on the computer monitor. The depth control of the flail and the armored deflector plate, which is positioned to the immediate rear of the rotating flail, is then fully automated using sensors. The chains rotate clockwise if mines are buried, and counter-clockwise if they are on the surface. The flail assembly consists of a rotating axle with 72 chains attached; the end of each of these is fitted with a hammer type head which weighs 0.9kg.


*The Mine Area Clearance Vehicle using it's flail in a mine clearing operation.*

ACC sought out the experts at the ML's Airbase Technology Division Force Protection Branch, at Tyndall AFB, FL, to integrate the remote control due to the branch's recent successes with a number of robotic vehicles. The effort to install a remote control system was funded through HQ ACC/CE with cost sharing from the Joint Robotic Program.

The MACV was delivered to ML, where it was equipped with the remote system. The system, developed by the Advanced Robotics Team and the Joint Architecture for Unmanned Systems, is operated via radio frequency using an ML-developed joystick controller, a laptop computer, and an Operator Control Station that houses the Ethernet and power for the system. A high end differential Global Positioning System was integrated which allows the remote operator to more accurately control the vehicle and which provides positioning feedback to ensure better accuracy. The Advanced Robotic Team engineers completed the programming and code work necessary to send and receive the required signals and messages.

Operating distance experiments were conducted in various environments; wide open areas and wooded areas, to determine the best radio and antenna combination to give the operators the best possible remote capability. Once ML

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# ML Helps Select Paint Stripper for Memphis Belle Restoration

A scientist from the Air Force Research Laboratory's Materials and Manufacturing Directorate (AFRL/ML) provided guidance to the Restoration Division of the National Museum of the United States Air Force to help restore the historic Memphis Belle.

This guidance resulted in the selection of Dekote by Aero-Chem LLC as the paint stripper to remove all the paint and coatings on the aircraft. The Memphis Belle is currently undergoing a long restoration process which may take up to 10 years to complete.

Aiding the National Museum of the United States Air Force in the selection of a paint stripper for the Memphis Belle restoration demonstrates ML's knowledge and expertise in coating technology and provides invaluable assistance to the museum. ML's involvement resulted in significant time savings for the Restoration Division during the selection process. The use of Dekote as a paint stripper also reduces the exposure of Air Force personnel to harmful chemicals.

In October 2005, the Memphis Belle, a Boeing B-17 that flew 25 missions during World War II and took part in the war bond tours, was transferred from the Memphis Belle Memorial Association, Incorporated, to the National Museum of the United States Air Force (NMUSAF).

The aircraft was flown to Memphis in 1946, and had been displayed outside of the National Guard Armory from 1949 to 1987. In 1987, the aircraft was moved to Mud Island in the Mississippi River where it was displayed in a roof-covered pavilion until 2003. During all these years, the Memphis Belle had been susceptible to the elements and to vandals.

Upon arriving at the NMUSAF, it became one of the museum Restoration Division's highest priorities. The team plans to return the aircraft to its original state, however, this will prove a challenge due to the amount of corrosion and vandalism to which the aircraft has been subjected. The team estimates it will take 10 years to restore it to museum quality.

One challenge in this process was to find a paint stripper to begin removing the "paint stack-up" on the aircraft. The paint stack-up includes the pretreatment, which provides corrosion protection for the metal surface, the primer and the topcoat, which is the outermost paint layer. The team also wanted an environmentally safe stripper, as opposed to one that uses methylene chloride, which works effectively as a paint stripper but has been found to be a carcinogen (a cancer causing substance), which is harmful to workers. For this challenge, the Restoration Division sought out the help of ML's Coating Technology Integration Office (CTIO).

CTIO member 2nd Lt. Grant Parker recommended a variety of paint strippers to the restoration team. Lieutenant Parker and the NMUSAF Restoration Division team tested the various paint strippers by applying each one to a test panel for a 24-hour period. The Restoration Division decided on Dekote, an environmentally safe paint stripper manufactured by Aero-Chem LLC, of Oklahoma City. Dekote uses a benzyl alcohol and hydrogen peroxide mixture, as opposed to methylene chloride, to safely remove the paint in just one application. It was able to remove all the coatings on the Memphis Belle test panel in eight hours.

The Restoration Division has begun the process of removing the paint stack-up from the Memphis Belle using Dekote. They are also planning to use the product on other aircraft as well.

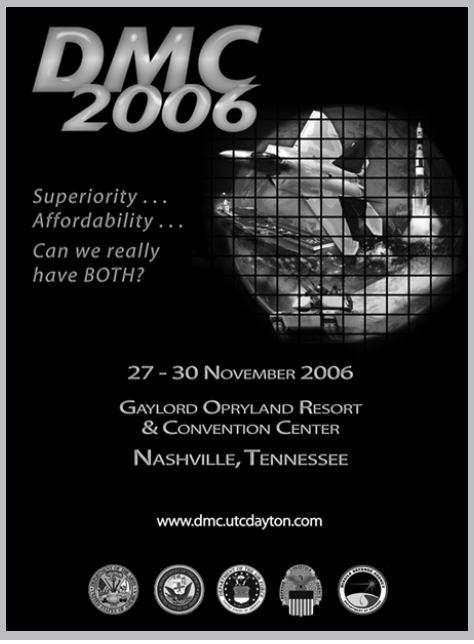
For more information, contact the Materials and Manufacturing Directorate's Technical Information and Support Center at techinfo@afrl.af.mil or (937) 255-6469. Refer to item 06-091.

## Defense Manufacturing Conference

The 2006 Defense Manufacturing Conference (DMC 06) will be held Nov. 27-30, at the Gaylord Opryland Resort and Convention Center, in Nashville, TN. Based on the theme, "Superiority, Affordability, can we really do both?", the agenda will is structured to bring together leaders from government, industry and academia to exchange perspectives and information about the DoD Manufacturing Technology program, industrial base initiatives and related DoD initiatives.

DMC has become the principal national forum for discussion of DoD industrial base policies, programs and capabilities, as well as counterpart industry initiatives. Critical issues include key technology development status, technology transfer and the opportunity for greater use of commercial industrial processes and business practices for defense needs.

For further information call the DMC 06 registration desk at (937) 426-2808, or visit the DoD ManTech Website at www.dmc.utcdayton.com.



# Handheld Laser Designed To Eliminate Costly Waste Streams

AFRL/ML scientists and engineers, working with the Air Force Materiel Command's Depot Maintenance Programs Division (HQ AFMC/A4B), identified and tested several portable handheld laser devices that can remove paint from small-area aircraft surfaces and individual aircraft components without the use of hazardous chemical strippers or abrasive blast media.

Laboratory test results were positive, and are helping the Air Force, Army, National Aeronautics and Space Administration (NASA), and commercial industry evaluate laser coating removal applications. The test results are also helping advance the development of fully-automated paint removal capabilities. The tests demonstrated that the handheld neodymium:yttrium-aluminum-garnet (Nd:YAG) laser system is a highly efficient and versatile tool for coating removal. Continued research could lead to the successful development of large scale, fully automated robotic systems that reduce or eliminate waste streams, lower costs, and provide reliable alternatives to conventional coating removal methods.


*The handheld laser coating removal system being used on a sample bracket.*

Currently, during routine aircraft maintenance operations throughout the Air Force, countless small areas are depainted to facilitate other maintenance such as surface inspection or replacement of damaged or degraded coatings. Traditional coating removal methods use hazardous chemicals or abrasive blast media. These conventional methods produce waste streams that are made up of toxic chemicals, such as methylene chloride and methyl ethyl ketone, or spent blast materials comprised of plastic pellets or wheat starch. Chemical strippers are high in volatile organic compounds (VOC) and hazardous air pollutants (HAP), both targeted for reduction/elimination by federal environmental regulations, including portions of the Clean Water Act, Resource Conservation and Recovery Act, and the Environmental Protection Agency's Toxics Release Inventory Report. Coating removal operations, including hand sanding operations, also require workers' protection and training under the Occupational Safety and Health Act (OSHA).

Because of these environmental concerns, the Air Force and all branches of the Department of Defense, NASA, and commercial industry are actively seeking alternative coating removal methodologies. Scientists and engineers at the AFRL Materials and Manufacturing Directorate (AFRL/ML) successfully identified and tested what proved to be a very effective portable handheld Nd:YAG laser device that can remove paint from aircraft without the use of chemical strippers or abrasive blast media, and can reduce or eliminate the need for time-consuming and labor-intensive hand sanding.

Laser coating removal is a non-intrusive, non-kinetic energy process that can be applied to a variety of substrate materials, including composites, glass, metal, and plastics. The applied energy is mostly absorbed and used to decompose the coating, resulting in instant evaporation that carries away most of the radiation energy. The substrate experiences only a minimal increase in temperature. Therefore, there is no appreciative impact on the substrate material, and the only waste generated is the removed coating. Extensive laboratory testing confirmed that lasers could effectively remove typical aircraft coatings without causing unacceptable changes in substrate properties such as strength and resistance to metal fatigue. Additionally, occupational safety and health testing showed workers using laser systems would not be exposed to high levels of airborne vapors and contaminants characteristic of abrasive blasting or chemical paint removal methods.

The researchers completed a cost benefit analysis to estimate the impact of installing an Nd:YAG laser system for supplemental coatings removal from aircraft parts, such as nose domes, cowlings and spoilers. The analysis showed an annual waste disposal cost savings greater than $10,000 and a yearly cost avoidance exceeding $80,000, since the depot considered in the analysis would not have to purchase or use a percentage of the chemicals, personal protective equipment or water, presently used during the chemical depainting process. The analysis also showed an adjusted environmental compliance cost avoidance of nearly $7,000 per year. If similar cost savings were assumed at all three of the major Air Force depots that perform chemical depainting operations on aircraft parts, the combined cost estimates would produce an environmental savings of almost $250,000 and an annual cost avoidance of nearly $300,000.

The Air Force would also realize significant labor savings as a result of increased stripping rates, (over the chemical process), as well as savings in preparation and cleanup time. A major objective of the program, and key success, has been worker health and safety and environmental protection. The Air Force continues to place high importance on these issues.

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was confident that they had the most robust system possible, explosive experiments were done to ensure the systems would withstand the shock of detonations with no degradation to the systems.

It was found that the remote operator can be up to a mile away, without any major obstructions between the antenna at the operators' end and the MACV. For most operations they will probably be 2000 – 3000 feet away. The conversion took nine months.

The 823rd RED HORSE Squadron at Hurlburt Field, FL., was chosen as the pilot unit for this project. This squadron usually deploys with heavy construction equipment to austere locations. ACC wanted to put the vehicle into the hands of the personnel who would be using it during regular deployment. This provides the squadron with experience operating the system.

ACC is working with Central Air Forces, the air component responsible for the US Air Force contingent of Operation Enduring Freedom, to move the MACV to Bagram Air Base, Afghanistan in the future.

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The USAF Materials Technology Highlights is published quarterly to provide information on materials research and development activities by Air Force Research Laboratory's Materials & Manufacturing Directorate. For more information on subjects covered in "Highlights" or to be added to the "Highlights" mailing list, contact the Materials & Manufacturing Directorate Technology Information and Support Center at (937) 255-6469 or e-mail at techinfo@afrl.af.mil. Approved for Public Release (AFRL/WS 06-2030).

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